## Skull-flexing blasts may explain mystery brain injuries

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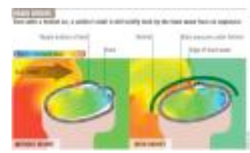
Mark Buchanan



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Brain bender

EXPLOSIONS too weak to kill can still deform the skull enough to cause lasting brain damage. This may help explain traumatic brain injuries in soldiers returning from Afghanistan or Iraq with no obvious head wounds.

Soldiers equipped with today's advanced body armour and helmets routinely survive explosions that would once have been lethal. After their visible wounds heal, however, many suffer from memory loss and other mental problems, conditions which could be the result of brain damage caused by exposure to blast waves.

How pressure waves might damage the brain is something of a mystery. One idea is that blast waves can travel up the major blood vessels into the brain (*Science*, vol 319, p 405). But Willy Moss and colleagues at the Lawrence Livermore National Laboratory in California think the effects of the blast might be more direct. They have created a computer simulation of a blast wave passing through a soldier's helmet and skull and into the brain. The conditions simulated corresponded to the blast created by 2.3 kilograms of C4 explosive detonated 4.6 metres from the soldier, which the team say is a plausible real-world scenario.

Their results show that the blast wave would cause the human skull to bend as it passes through, generating pressures in the brain comparable to those created by hitting your head in a violent car crash. "Even relatively weak blasts can cause the skull to flex enough to generate potentially dangerous pressures in the soft brain tissue," says Moss. The work has been submitted to *Applied Physics Letters* (www.arxiv.org/abs/0809.3468).

The results also suggest that a helmet does little to protect a soldier from these injuries, partly because the blast wave penetrates easily into the space between the helmet and the head (see diagram). The researchers hope their simulations will lead to better helmet design, but say any changes would have to made cautiously to avoid undermining the effectiveness of helmets. For example, making helmets more rigid might help guard against blast waves, but current helmets are deliberately designed with some flexibility to help absorb direct impacts to the head.

"The predictions are probably right," says Michael Courtney of the United States Military Academy at West Point, New York, though he adds that further experiments on cadavers are required to confirm the findings.

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